been the mapping and description, and probably, eventually, the care of the national forest reserves. This opens up a new branch of work in which temperature, rainfall, wind, and other meteorological conditions must be considered.

On page 116 of Mr. Walcott's report as director he states:

> The preparation of a physical atlas of the United States, upon which much work had been done in former years, was continued. Climatic maps were prepared, which include maps of mean monthly temperature, of annual pressure, cloudiness and snowfall, monthly and annual maps of relative humidity, and maps showing the range in temperature between the hottest and coldest months; in all 28 maps. Besides these diagrams have been prepared of the slopes of the rivers of the United States.

As nearly all the climatic data for the United States is preserved in the archives of the Weather Bureau, it would seem that the climatic maps prepared by the Geological Survey must be essentially the same as those prepared by the Weather Bureau. There are, undoubtedly, frequent inquiries for a physical atlas and, so far as meteorological elements are concerned, the Weather Bureau has furnished its data freely to all inquirers and has published that for which there seemed to be the greatest demand. Plans for a national physical atlas were submitted by Prof. Joseph Henry in 1847 for publication by the Smithsonian Institution. An atlas of this character was published by Gen. Francis A. Walker, in connection with the census of 1870, to which, at the suggestion of the present writer, the Weather Bureau contributed four meteorological charts. When Mr. Gannett was assigned to duty in the Census Bureau as geographer, in addition to his duties as Topographer in the Geological Survey, many climatic charts were prepared by him for the publications of the census of 1880, and a revision of these was begun for the eleventh census of 1890. It is evident that by the proper cooperation of the Weather Bureau (as to meteorology and hydrology), the Geological Survey (as to topography, hydrography, seismology, geology, and mineral springs), the several divisions of the Department of Agriculture (as to soils and forests), and the Coast and Geodetic Survey (as to magnetism, terrestrial gravity, and tides), our national government is now in a position to prepare a physical atlas of the United States, embracing every branch of terrestrial physics. An atlas that does not embrace all these must, necessarily, be incomplete and more or less unsatisfactory. A joint work for which each Department of the Government assumes the proper responsibility would respond to a recognized desideratum.

RECENT EARTHQUAKES.

Prof. Edward W. Morley, of Adelbert College, Cleveland, Ohio, and Prof. C. F. Marvin, of the Weather Bureau at Washington, report that no earthquakes have been recorded on their respective seismoscopes during December.

December 2.—Medicine Lodge, Kans.: about 12:45 a. m. a slight shock was experienced in this locality. Duration, about five seconds; direction, south to north. Rome, Kans.: about 1 a. m. Jefferson, Okla.: at 1:10 a. m. an earthquake shock, quite severe; rocked buildings, making them creak and crack; the disturbance seemed to be from northwest to southeast.

December 6.—Forest Grove, Oreg.: slight shock at 8:30 p. m.

December 15.—Waterville, Wash.: earthquake; duration four to six seconds; direction, northwest to southeast. Lakeside, Wash.: A severe shock.

December 15.—At 6:43 a. m., local time, severe earthquake, causing great damage throughout San Domingo. A second slight movement at 2 p. m. Churches and buildings were destroyed and railroad traffic interrupted. The submarine cable to Hayti was also affected. The grand edifice of Santo Cerro, in Santiago, in the interior of San Domingo, dating from the time of Columbus, was entirely destroyed. A continued repetition of harmless shocks occurred until the end of the month.

December 16, 17, 20.—Lakeside, Wash.: light shocks, all occurring at 6 a. m., vibrating from west to east.

December 18.—Earthquakes were reported at Ashland, Va., 6:54 p. m.; slight shock, with heavy rumbling noises, lasting from twenty to thirty seconds. Richmond, Va.: Shortly before 7 p. m. earthquake noticeable everywhere, but more violent in the eastern part of the city, toward Oakwood. At Oakwood it was heard and felt very distinctly. At Bonair and throughout Henrico County, Va., it was heard and felt; also at Buckingham and Maidens at 6:49 p. m., and at Fredericksburg.

December 26.—Centerville (P. O. Niles), Cal.: earthquake 7:06 a. m.; duration, five seconds; direction, north to south.

December 29.—Cockburn Town, Grand Turk, W. I.: Mr. Geo. J. Gibbs reports:

> On the morning of Wednesday the 29th day of December, 1897, at about 6:37 o'clock a. m., a slight shock of earthquake was felt at the Island of Grand Turk, lasting a few seconds. No damage was done; it was sufficiently strong, however, to stop the movement of the Government clock at the public buildings, and also several other timepieces in this town; symptoms of nausea were experienced by some of those who felt the trembling of the earth.

ELECTRIC STORMS AT SACRAMENTO.

The cause of the electrification of the atmosphere, from which follows the electrical phenomena of the thunderstorm, will, of course, not be understood until we have been able to explain how it happens that in some sections of the world there are so few thunderstorms, while in others they are of almost daily occurrence. A portion of California is singularly free from lightning, as shown by the following compilation from the records of the Weather Bureau station at Sacramento. The Weather Bureau station at this place was opened July 1, 1877, and the daily journal kept at the station probably affords a complete list of all the thunderstorms (viz, even a slight display of thunder or lightning) that have occurred. The following is the complete list of dates as corrected and continued from the list published on page 105 of Mr. Barwick's Monthly Bulletin of the California Weather Service for June, 1893:

1877.—July 20.
1878.—January 22; March 20; May 28; August 15.
1879.—March 30; April 4, twice; May 25; October 7.
1880.—March 3; June 11; July 25.
1881.—April 9, 21; May 23; June 3.
1882.—March 15; June 14; July 3; September 15.
1883.—March 27; May 6.
1884.—May 17, 18, 19.
1885.—April 2, 7, 8; September 5, 6; October 6.
1886.—January 20; March 4; April 9.
1887.—May 30; September 22; November 5.
1888.—May 12, 13; September 14, 15, three storms.
1889.—March 10, 20; April 2; October 8, 21; November 18.
1890.—February 16; May 10; December 3.
1891.—February 22; April 13; May 18; September 5.
1892.—September 26, 29, 30.
1893.—March 11; May 17; September 6.
1894.—May 25; June 17.
1895.—April 27; June 28; October 11.
1896.—May 27.
1897.—August 18, 19; December 1.

In most cases the display of lightning and thunder was very slight. The following notes refer to interesting cases:

1885, October 6, forked lightning occurred in the shape of a horseshoe.

1887, September 22, brilliant and long flashes of zigzag or forked lightning.

1888, September 14, 15, there were five distinct and severe storms with lightning and thunder in the vicinity of Sacramento during these two days.

1889, March 20, there was a succession of twelve flashes of zigzag lightning followed by as many loud peals of thunder; this was the longest display of lightning ever recorded here.

1889, April 2, a severe storm of forked lightning and thunder.

1891, September 5, a tree was struck by lightning.

1897, December 1, the second time that lightning occurred in December. The thunderstorm began at 4:05 a. m., seventy-fifth meridian time, and lasted about six minutes, during which time there were four flashes of lightning in the southwest, and the same number of loud peals of thunder. The lightning flash was of the zigzag or chain or forked variety, and was intensely white in color; the rainfall during the night (from 8 p. m. to 8 a. m.) was 0.10 inch; during these same twelve hours 5 inches of snow fell at Summit, 4 at Truckee, and 1 or 2 inches at other points on the mountains 50 or 100 miles west of Sacramento, and at points 3,000 feet or more above that station.

DISTANT CLOUD BANKS.

A letter from Mr. James Gun, of Durham, Grey County, Ontario, says:

I have often, when engaged in my practice in the country, observed these banks of clouds; especially when, having reached a height of land, I found myself placed in such a position that (by the refraction of the rays of light?) these clouds assumed the appearance of bodies of water, something after the appearance of a mirage. These cloud banks have been invariably, in my experience, followed by changes of weather and storms.

The Editor remembers to have seen in the distance about the time of sunset low clouds that closely resembled a distant lake or an ocean horizon. Of course the resemblance to such a solid mass of water was purely an optical delusion, and not due so much to the refraction that produces mirage, as to the peculiar tints of the blue sky, the clouds, and the ground at sunset. These were not the cloud banks that the Editor had especially in mind in his little note in the October REVIEW, but we are much obliged to Mr. Gun for calling our attention to them, and hope that other observers may put their observations on record.

CLOUDY CONDENSATION.

The researches of John Aitken, which have for the past twenty years been published from time to time in the "Transactions of the Royal Society of Edinburgh," have made the English-speaking world familiar with the fact that has been established by him and others, that whenever the aqueous vapor of the atmosphere condenses into the little globules that constitute fog or cloud it, by preference, condenses first upon the particles of so-called dust floating in the air which are, therefore, the nuclei of cloudy condensation. According to the last publication by Aitken (R. S. Edin., XXXIX, Part I, p. 15, 1897) he states that he has never said that dust particles are absolutely essential, but simply that as the air is full of dust and the condensation takes place on these by preference, therefore, practically all of our cloud particles have dust nuclei. The researches of Robert von Helmholtz and Professor Richarz and those of Prof. Carl Barus, as published by the Weather Bureau, agree with those of Aitken in showing that, in the absence of dust cloudy condensation also occurs, but the solid nuclei are replaced by molecules of some other foreign substances, such as the vapor of sulphuric acid, or the particles given off by anhydrous sulphuric acid, or even from metal surfaces when heated or electrified.

It has been suggested that, in the absence of dust nuclei, condensation may be produced by a molecular shock due to chemical processes, and more especially by the presence of the unsaturated molecular compounds known in chemistry as "ions." This last memoir by Aitken gives in detail an experimental method of determining the importance of these ions, especially those produced by the burning of pure hydrogen in pure air. Special pains were taken to obtain air and hydrogen perfectly free from dust, for when a single particle of dust is burned in the flame it gives rise to innumerable free atoms of carbon which becomes solid nuclei for condensation. Aitken's experiments show that in his apparatus the ions had no perceptible influence, whence he draws the safe conclusion that if they really had much influence in producing condensation they could have retained that power for only a very short time, viz, a fraction of a second, and it is not likely that they play any important part in the ordinary cloudy condensation of the atmosphere.

Mr. Aitken next turned his attention to the question of the direct influence of sunshine in producing condensation, a matter which was first brought to the attention of the world by the brilliant experiments of Tyndall, who describes the beautiful clouds produced by allowing a beam of light to pass through a long tube full of dustless, saturated vapor. Mr. Aitken finds that many of the vapors which we call impurities in our atmosphere, such as ammonia, nitric and nitrous acids, peroxide of hydrogen, sulphurous acid, sulphuretted hydrogen, hydrochloric acid, and chlorine give rise to nuclei of condensation when acted on by sunshine. Each of these, in a clean tube, was exposed to sunshine for about a minute. Ordinary pure air, after being filtered of dust and exposed to sunshine, does not show any cloudy condensation when expanded, but when any of the above-named gases are in the air a great deal of cloud is formed. Ammonia, after being sunned for a minute, has a very powerful effect; nitric acid not so much; nitrous acid probably as much as nitric acid. Hydrogen peroxide is a powerful generator of nuclei; sulphurous acid gives rise to condensation even in the dark and in a weak solution, but sunshine increases it; illuminating gas and the gases given off by the combustion of anthracite coal give a dense condensation after being exposed to sunshine, but these gases probably contain sulphur; pure sulphuretted hydrogen and hydrochloric acid give dense condensation after being exposed to the sunshine, but none when they are kept in the dark; chlorine causes condensation if kept in the dark and without being expanded and is still more fogged on exposure to sunlight. Some of these nuclei of condensation, due to the action of sunshine on the above-mentioned vapors, are very short lived, so that the air in the experimental flask loses the power of cloudy condensation in from fifteen to thirty minutes; but the nuclei from sulphurous acid do not lose their power for a long time; these nuclei are probably particles of fine sulphur dust and their action is as permanent as ordinary atmospheric dust. The light of burning magnesium acts on sulphurous acid easily, but scarcely at all on the other vapors. These experiments on the effects of sunshine on the gases ordinarily present in the atmosphere show that it is possible for cloudy condensation to take place in the absence of dust, since the sunshine may convert vapors into the nuclei of condensation. There is, indeed, always dust enough in the lower atmosphere, but we now see how it may become possible for clouds to form in the dustless higher strata.

ON THE TENSION OF AQUEOUS VAPOR.

Prof. Joseph Henry early called attention to the fact that the air is not necessarily saturated during rain, and he says (Smithsonian Annual Report, 1855, pp. 213–214, or Scientific Writings, Vol. II, p. 5):

That the air should ever be undersaturated during rain is at first thought a very surprising fact; it may, however, be accounted for on the principles of capillarity. The attraction of the surface of a spherical portion of water for itself is in proportion to the curvature or to the smallness of the quantity, and hence the tendency to evaporate from a raindrop ought to be much less than from an equal portion of a flat surface of water.